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WHOLE PULSES AS FUNCTIONAL FOODS FOR THE REGULATION OF FOOD INTAKE AND GLYCEMIC RESPONSE

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PROJECT TITLE:

"WHOLE PULSES AS FUNCTIONAL FOODS FOR THE REGULATION OF FOOD INTAKE AND GLYCEMIC RESPONSE"

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ABSTRACT:

Increased utilization of foods and food components that can be shown to contribute to improved regulation of food intake and satiety has potential to provide a safe and effective approach to prevent and manage the obesity epidemic. Little is know about the effect of pulses on food intake and satiety but their consumption is associated with healthier body weights. Therefore the objective of this study was to investigate the effect of consuming various pulses on subsequent blood glucose concentration, satiety and food intake. Young men (18-35 y of age, BMI 20-25) were fed a 300 kcal serving of pulses in tomato sauce and their blood glucose and subjective feelings of appetite were measured over two hours and food intake from a pizza meal was measured at 120 min. The serving of pulses, with the exception of chickpeas, suppressed food intake two hours later. An inverse interaction was found between food intake and blood glucose. That is, the higher the blood glucose prior to the meal, the less the subjects ate at the meal. Chickpeas consumption caused lower blood sugar than white bread but resulted in higher food intake. We conclude that consumption of a serving of pulses, with the exception of chickpeas, suppresses appetite and food intake for up to for two hours.

INTRODUCTION:

Our research aims to investigate the role of pulses in the regulation of food intake, and in the modulation and prevention of associated chronic diseases.

According to the data from Canadian Community Health Survey in 2004, 23.1% of Canadians aged 18 or older, an estimated 5.5 million adults were obese and another 36.1%, around 8.6 million Canadian adults were overweight. Rate of obesity among men almost doubled and it rose in 1.5 times among women in last 25 years [1]. About 26% of Canadian children in 2004 aged 2 to 17 were overweight or obese. This number rose more than twofold in the last 25 years [2]. The main reason for obesity is that the quantity of energy consumed from food sources is much higher than energy expenditure, explained by sedentary life-style, low consumption of vegetables and fruit, low physical activity, and by pernicious habits. As one possible solution to the obesity epidemic, our overall research approach is to understand the effect of foods and their components on satiety and food intake [3]. Of specific interest is the relationship between the blood glucose response to carbohydrate foods and their affect on satiety and food intake.

In this study we used whole pulses as functional food to modulate the physiologic processes that regulate short-termfood intake. Pulses (beans, chickpeas, lentils, and peas) contain many bioactive and functional components that can maintain and improve health [4-6]. Pulses are a highly nutritious food. Canada's new Food Guide [7] recommended that Canadians should consume 2-3 servings of Meat and Alternatives, including legumes (beans, lentils, chickpeas,

peas) daily. The three macro components in pulses that can potentially induce satiety and regulate blood glucose include protein, dietary fiber and resistant starch. An additional advantage of pulses is their low fat content (0.3 – 1.1%). The literature promotes pulses as beneficial in the management of diabetes and obesity based on their characterization as low glycemic foods (4-6). However, the hypothesized relationship between the glycemic response to pulses and subsequent satiety and food intake has not been directly tested. This study investigated the effect of feeding a 300 kcal serving of whole pulses (chickpea, lentil, and pea) on subsequent food intake, satiety and blood glucose response. The pulse treatments were obtained from commercially canned products from the grocery store to which was added a tomato sauce to improve palatability and contained approximately 50 g of available carbohydrate.

The objective of this research was to evaluate the effect of consuming whole pulses (canned chickpeas, lentil, yellow peas and lentils) on satiety, short-term food intake, and glycemic (blood glucose) response.

DESIGN AND METHODS:

The study utilized a repeated measures design in which the subjects returned at weekly intervals to consume each of the six treatments provided in random order. Because the treatments are provided independent of other foods followed by measurement of subjective satiety and blood glucose concentration and food intake at a later meal, the treatments are referred to as preload treatments.

Subjects [*13 healthy, non-smoking males, age 18-35 years (mean = 21yr) BMI 20-25 kg/m^2 (mean = 23 kg/m^2)*] were required to arrive for each test session at the same time of the morning after fasting overnight (10-12h). Water was permitted up to one hour before the scheduled start time. All subjects were instructed to maintain a regular pattern of food intake and physical activity throughout the study, and to be particularly consistent in their eating, sleeping and exercise habits for the day before and morning of each session. Upon arrival, subjects filled out a Sleep Habits and Stress Factors Questionnaire inquiring about any unusual events or illness, and a series of Visual Analogue Scale (VAS) questions to determine whether they have complied with the study requirements. Any deviation from a normal pattern resulted in cancellation of the test for the day. Subjects were asked to record the contents of their dinner on the previous night and a reminder emails was given to eat a similar meal on the nights prior to their remaining sessions.

All treatments (the preload treatments), except water, were served with 118 g of tomato based sauce and provided 300 kcal. Pulse treatments included canned navy beans (1 cup), lentils (1.25 cups), chickpeas (1 cup), yellow peas (1.25 cups) obtained as canned preparations (Can Grow Foods, Heinz) from the grocery store. White bread and water served as controls. White bread was made in the experimental kitchen. Crust was removed.

Baseline visual analogue scale (VAS) questionnaires measuring motivation to eat (appetite) and physical comfort were completed and a fasting finger-prick

blood samples taken upon arrival (baseline), and repeated at selected intervals after the treatment. The preload treatments were consumed with in 10 minutes. At the end of 120 minutes, an ad libitum pizza meal (McCain pizzas, each approximately 200 kcal cut in four, choice of three varieties, fresh trays served every six minutes) and a bottle of water were served and the subject instructed to eat until comfortably full.

Blood samples were taken by finger-prick, using Monojector Lancet Devices (Sherwood Medical, St. Louis, MO, U.S.A.). Blood glucose concentration measured with a portable blood glucose analyzer (Accu-chek Compact, Roche Diagnostics) by placing one drop of blood on a preloaded, automatic release test strip.

Food intake was measured by weighing the cooked pizzas before serving, and re-weighing the leftover to determine the net weight consumed. After finishing the pizza lunch, subjects rated the palatability of the meal and complete a final motivation to eat questionnaire.

Statistical analysis was performed with SAS/STAT software (SAS Institute Inc., NC, U.S.A.).

RESULTS:

Average Appetite

All pulses treatments suppressed subjective appetite compared to water. The strongest suppression was observed with yellow peas after 15 minutes. Appetite was significantly suppressed ($p<0.05$) by yellow peas, lentils and navy beans during 2 hours and by chick peas for 90 minutes. White bread was not different ($p>0.05$) from water in appetite score after 60 minutes. However appetite remained lower after lentils, navy beans and yellow peas.

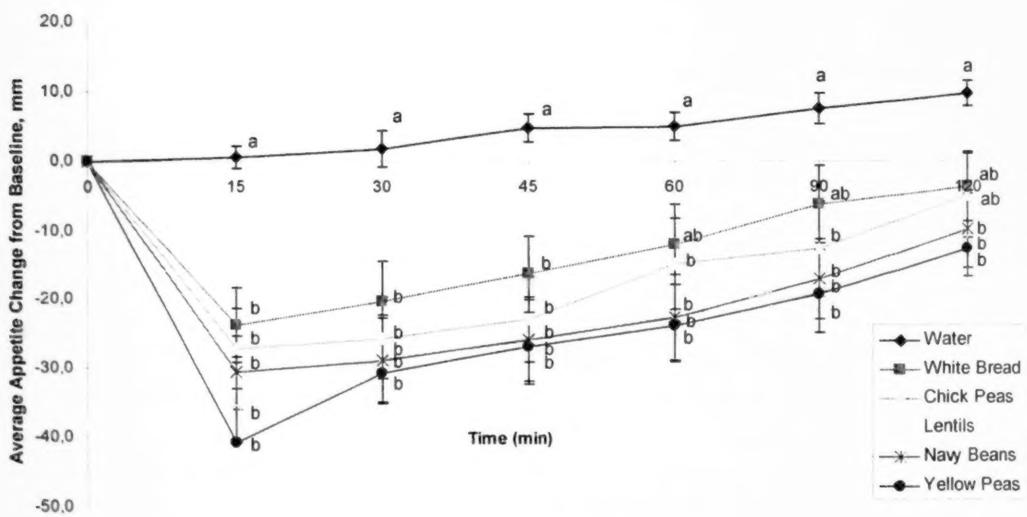

Figure 1: Change in average appetite after treatments

Average appetite scores were measured at baseline and 15, 30, 45, 60, 90 and 120 min following treatment. At each time point, points with different subscripts are significantly different. Mean ± SEM; n=13; p<0.05 Tukey's post hoc test.

Blood Glucose

Blood glucose concentrations, expressed as the difference from baseline, were affected by treatment and time. White bread produced the highest glucose response among the treatments. The lowest glucose concentrations were observed after the preloads with lentils and chick peas. After 15 and 30 minutes lentils, chick peas and yellow peas caused significantly lower ($p<0.05$) glucose responses compared to white bread. This effect lasted up to 45 minutes for lentils and chick peas and only for lentils remained at 1 hour.

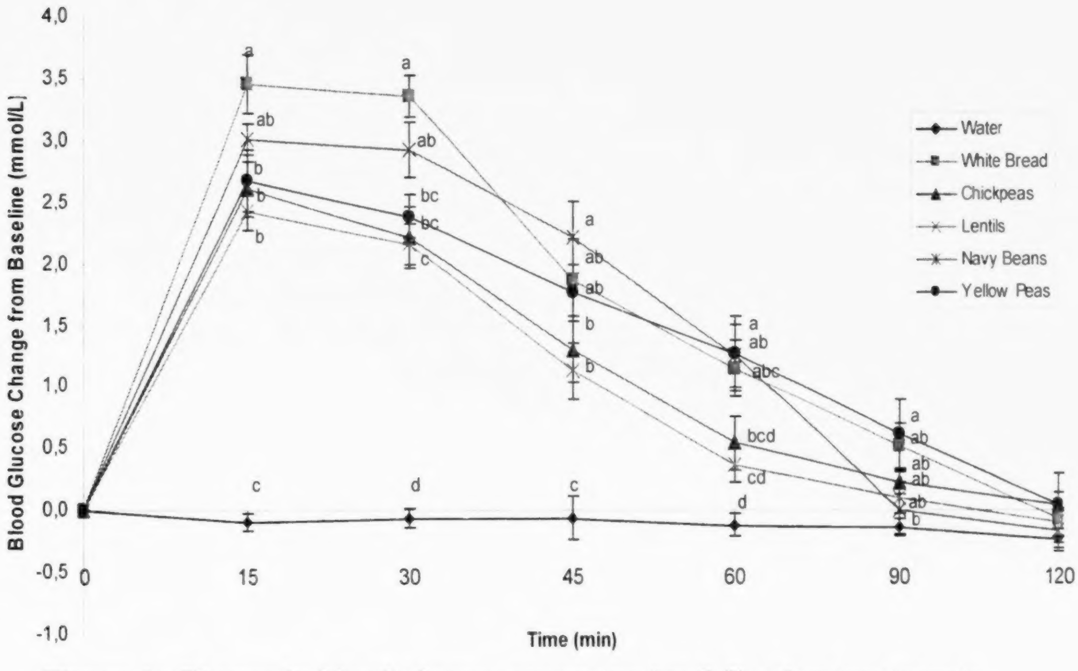

Figure 2: Change in blood glucose concentration following treatments

Change from baseline blood glucose concentration was measured at baseline and 15, 30, 45, 60, 90 and 120 min following treatment. Points at each time point with different subscripts are significantly different. Mean + SEM; n=13; p<0.05 Tukey's post hoc test

The area under the curve (AUC) for blood glucose differed among treatments (Figure 3). Preload with lentils and chickpeas have significantly lower (p<0.05) AUC compared to white bread and lentils has the lowest blood glucose AUC among assayed pulses. Blood glucose AUC for yellow peas was significantly lower (p<0.05) from white bread AUC, but higher compared to lentils and chickpeas. Navy beans did not significantly differ from white bread.

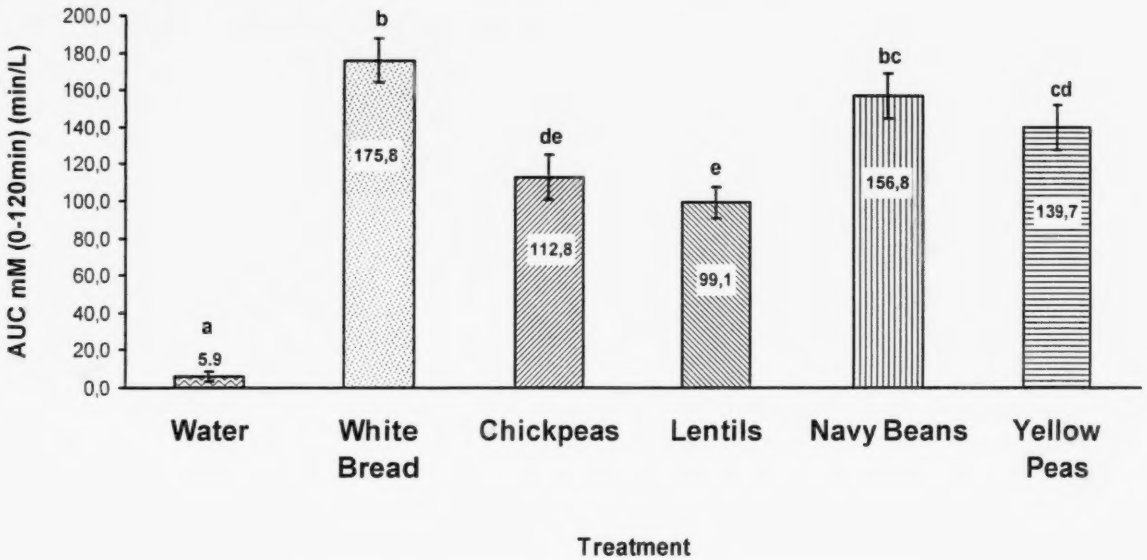

Figure 3: Blood glucose AUC after treatments

Net area under the curve (AUC) for blood glucose concentrations to 120 min after the consumption of 6 preloads. n = 13. Mean ± SEM. Bars with different letters are significantly different, P < 0.05

Food Intake

Two hours after the preloads were consumed, there was a significant effect (p<0.05) of all treatment (except chickpeas) on energy consumed at the test meal compared to water (Figure 4). Lentils, navy beans and yellow peas suppressed food intake similarly to white bread.

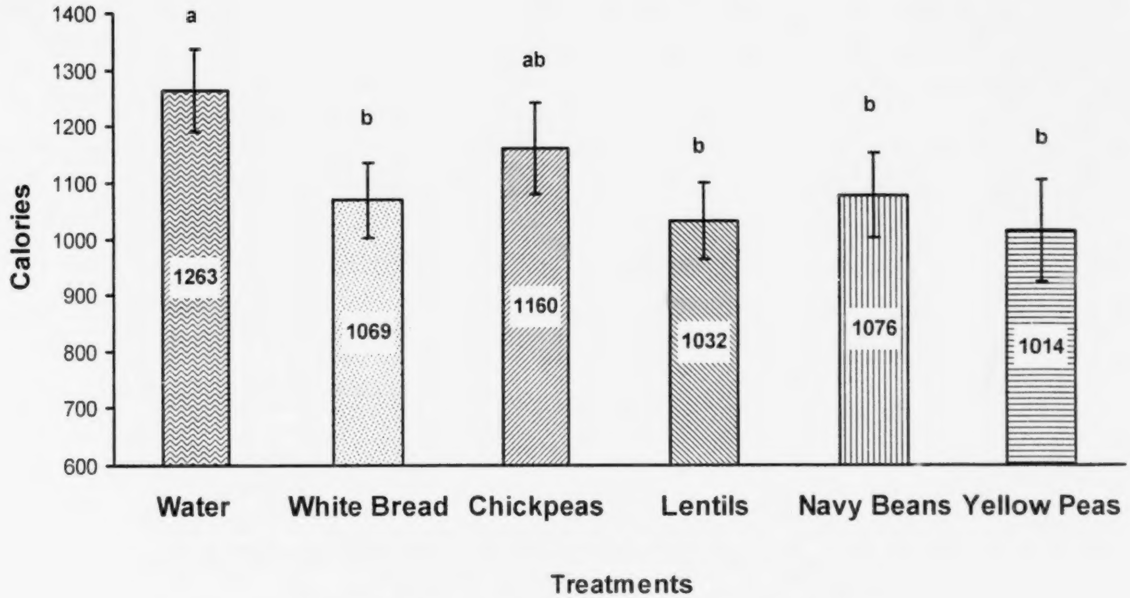

Figure 4: Food Intake after Treatments.
Food intake after the consumption of 6 preloads. n = 13. Mean ± SEM. Bars with different letters are significantly different, P < 0.05

An inverse correlation (r = -0.40, p = 0.003) was found between food intake at 120 min and the area under the curve for blood glucose concentrations after the consumption of chickpeas, navy beans, lentils, and yellow peas (Figure 5). The higher the blood glucose response, the lower the food intake at the test meal.

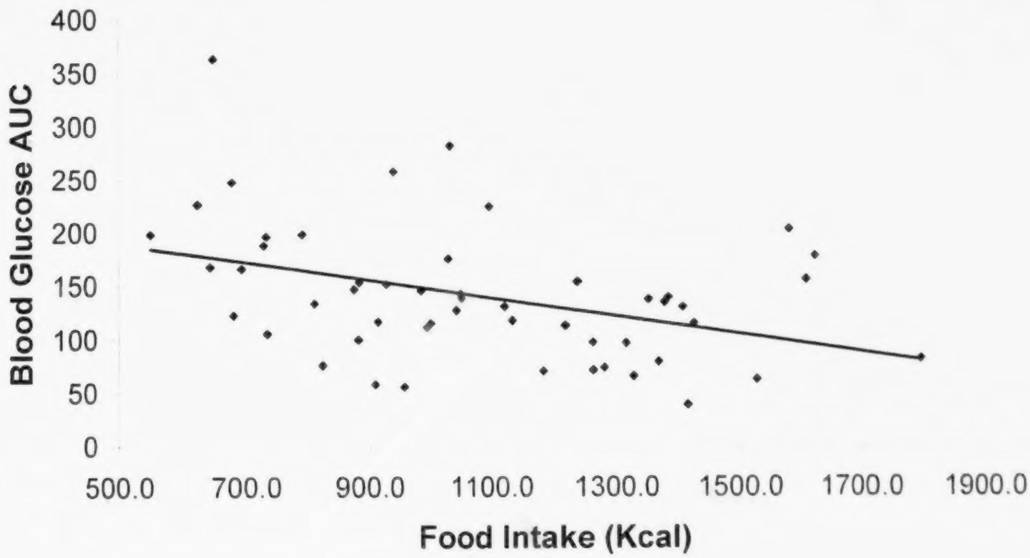

Figure 5: Correlation between food intake and blood glucose AUC

Relation between food intake at 120 min and the area under the curve (AUC) for blood glucose concentrations after the consumption of Chickpeas, Navy beans, Lentils and Yellow peas. ($r = -0.40$, $p = 0.003$, $N=52$).

CONCLUSION

We conclude that consumption of a serving of pulses, with the exception of chickpeas, suppresses appetite and food intake for up to for two hours. An inverse interaction was found between food intake and blood glucose. That is, the higher the blood glucose prior to the meal, the less the subjects ate at the meal.

DISCUSSION:

It was disappointing to find that pulse consumption did not reduce food intake at the test meal more than white bread, as has been previously hypothesized to be a benefit of consuming low GI foods (4-6). The higher the blood glucose response was after the pulse preloads, the lower the food intake at the test meal. Chickpeas produced one of the lowest blood glucose responses among the treatments but also resulted in the highest food intake among the treatments at two hours and did not result in lower food intake than the water control.

It should not be surprising, however, to find that a higher blood glucose response associates in the short-term with greater subjective satiety and lower food intake. Blood glucose and insulin responses are among the strongest short-term satiety signals post consumption and reflect the quantity and availability of carbohydrate in the food consumed (3). Thus canning of pulses to increase palatability, carbohydrate availability and convenience of consuming pulses is a positive aspect of processing. Furthermore, it may be suggested that the benefits of pulses in body weight control arises from two components, namely short-term satiety due to the increase in blood glucose and insulin, and possibly due to a long term-effect of frequent consumption on increased fiber in the colon and colonic fermentation. The pulses in the amount served in this study provided between 20-16 g of fiber. Compared to many processed carbohydrate foods that raise blood glucose and contribute to satiety in the short-term, pulses contain significant amounts of essential nutrients and are a good source of protein, conveying additional health advantages.

RECOMMENDATIONS

Further studies are required to elucidate the effect of pulses on satiation (the termination of eating), the duration of satiety when consumed alone or with a meal, the effect on blood glucose response following a later meal, and the effect of frequent consumption (five days per week for two months) on body weight and on health biomarkers including blood lipids and glucose. Many of these studies will be conducted with support received from Pulse Canada.

The outcome of these continuing studies as well as studies aimed at evaluating the effects of isolated fractions of pulses (e.g. proteins and fibers) will point to potential processing modifications to enhance the health benefits of canned products and to development of products (e.g. snack foods, health bars and beverages) that provide convenient and increased opportunity for consumers to benefit from the health benefits of pulses.

ACKNOWLEDGEMENTS:

Saskatchewan Department of Agriculture and Food was acknowledged in the following scientific/industry meetings:

1. C. Wong, F. Cho, G.H. Anderson, and D. Yeung. The effect of pulses on glycemic response, satiety and food intake in young men. Poster presented at Toronto CIFST section Technical meeting, Molson Brewry Pub, Mississauga, April 6, 2006.

2. C. Wong, F. Cho and G.H. Anderson. The effect of pulse variety on glycemic response, subjective appetite and food intake. 6th Canadian Pulse Research Workshop, Saskatoon Saskatchewan, November 1-3, 2006. (note-Christina won second prize in student competition).

3. C. Wong. The effect of pulses on glycemic response, satiety and food intake in young men. Department of Nutritional Sciences, University of Toronto. Seminar December 14, 2006.

Acknowledgements to Saskatchewan Department of Agriculture and Food for financial support of this study will be made in succeeding research publications.

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